

construction of particular tables for each satellite. The Valz Prize has been awarded to Dr. Spörer for his researches on sun-spots,—his discovery of the striking relationship between the distribution of the spots in latitude and the epochs of their maxima and minima receiving especial notice.

FABRY'S COMET.—The following ephemeris from elements he has recently computed is given by Dr. S. Oppenheim in the *Astr. Nach.*, No. 2702 :—

Ephemeris for Berlin Midnight

1886	App. R.A. h. m. s.	App. Decl. h. m. s.	Log. Δ	Log. r	Bright- ness.
Jan. 9 ...	23 36 33 ...	21 12 51 ...	0.2478 ...	0.2523 ...	1.40
11 ...	35 0 ...	20 38 ...			
13 ...	33 35 ...	29 19 ...	0.2514 ...	0.2382 ...	1.47
15 ...	32 16 ...	38 54 ...			
17 ...	31 4 ...	49 23 ...	0.2543 ...	0.2236 ...	1.55

BARNARD'S COMET.—Dr. J. von Hepperger has computed the following parabolic and elliptic elements for this comet :—

	Parabola	Ellipse
T	1886 May 6.2586	1886 May 4.5165
ω	118 57 9.9	121 41 24.9
Ω	67 42 52.2	68 37 19.7
i	87 24 30.0	82 51 6.2
log q	9.695574	9.665966
log a		1.336444
log e		9.990625

Error of the middle place ($0 - C$).

$$\begin{aligned} d\lambda &= -2.4 & d\lambda &= +4.8 \\ d\beta &= -3.9 & d\beta &= +1.9 \end{aligned}$$

The following ephemeris is by Dr. A. Krueger :—

Ephemeris for Berlin Midnight

1886	App. R.A. h. m. s.	App. Decl. h. m. s.	Log Δ	Log r
Jan. 9 ...	2 53 7 ...	+ 9 41.1 ...	0.3497 ...	0.2112
11 ...	49 7 ...	10 2.7 ...		
13 ...	45 16 ...	10 24.8 ...	0.3383 ..	0.2131
15 ...	41 34 ...	10 47.3 ...		
17 ...	38 2 ...	11 10.2 ...	0.3265 ...	0.2155

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 10-16

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 10

Sun rises, 8h. 5m.; souths, 12h. 7m. 51.1s.; sets, 16h. 11m.; decl. on meridian, $21^{\circ} 55'$ S.: Sidereal Time at Sunset, 23h. 31m.

Moon (at First Quarter on Jan. 13) rises, 10h. 17m.; souths, 15h. 56m.; sets, 21h. 45m.; decl. on meridian, $4^{\circ} 41'$ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian
Mercury ...	6 25 ...	10 27 ...	14 29 ...	$22^{\circ} 6'$ S.
Venus ...	9 41 ...	14 55 ...	20 9 ...	$9^{\circ} 43'$ S.
Mars ...	21 53* ...	4 24 ...	10 55 ...	$5^{\circ} 21'$ N.
Jupiter ...	23 7* ...	5 5 ...	11 3 ...	$1^{\circ} 5'$ S.
Saturn ...	14 44 ...	22 54 ...	7 4* ...	$22^{\circ} 35'$ N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon

an.	Star	Mag.	Disap.	Reap.	Corresponding angles from ver- tex to right for inverted image
14 ...	B.A.C. 830	6	h. m.	h. m.	
16 ...	θ^1 Tauri	4.1	19 9 ..	20 11 ...	$75^{\circ} 343'$
16 ...	θ^2 Tauri	4.1	15 56 ...	16 58 ...	$66^{\circ} 244'$
16 ...	75 Tauri	6	15 58 ...	16 56 ...	$45^{\circ} 264'$
16 ...	B.A.C. 1391	5	16 33 near approach	155 —	
16 ...	80 Tauri	6	16 58 ...	17 57 ...	$93^{\circ} 224'$
16 ...	81 Tauri	5.1	17 5 near approach	337 —	
16 ...	85 Tauri	6	17 20 near approach	338 —	
16 ...	Aldebaran	1	17 55 near approach	340 —	
16 ...		1	19 48 ...	20 49 ...	$122^{\circ} 248'$

Phenomena of Jupiter's Satellites

Jan.	h. m.	II. ecl. disap.	Jan.	h. m.	I. ecl. disap.
11 ...	4 4	II. tr. ing.	14 ...	23 53	I. occ. reap.
13 ...	1 29	II. tr. egr.	15 ...	3 16	I. tr. egr.
13 ...	4 15	I. ecl. disap.	16 ...	0 25	III. tr. ing.
13 ...	5 24	I. tr. ing.	16 ...	4 59	III. tr. egr.
14 ...	3 42	I. tr. egr.	16 ...	7 45	III. tr. egr.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich. Attention may be drawn to the Occultations occurring on the evening of January 16, and especially to that of Aldebaran.

Jan.	h.	
10 ...	12	Saturn in conjunction with μ Geminorum and less than $1'$ north of that star.
13 ...	—	Venus at her point of greatest evening brilliancy.

Variable-Stars

Star	R.A.		Decl.				h.	m.
U Cephei	0	52.2	81°	16 N.	Jan.	13,	0	24 <i>m</i>
Algol	3	0.8	40°	31 N.	...	14,	2	22 <i>m</i>
						16,	23	11 <i>m</i>
T Monocerotis ...	6	19.1	7°	9 N.	...	15,	17	0 <i>m</i>
ξ Geminorum ...	6	57.4	20	44 N.	...	13,	2	30 <i>M</i>
U Monocerotis ...	7	25.4	9	32 S.	...	10,		
δ Libræ	14	54.9	8°	4 S.	...	12,	17	47 <i>m</i>
						15,	1	38 <i>m</i>
U Coronæ	15	13.6	32°	4 N.	...	13,	1	24 <i>m</i>
U Ophiuchi ...	17	10.8	1°	20 N.	...	11,	1	39 <i>m</i>
						11,	21	47 <i>m</i>
					and at intervals of	20	8	
R Lyræ	18	51.9	43°	48 N.	Jan.	10,		<i>M</i>
η Aquilæ	19	46.7	0°	43 N.	...	12,	5	0 <i>M</i>
δ Cephei	22	24.9	57°	50 N.	...	12,	2	30 <i>m</i>
						13,	17	0 <i>M</i>

M signifies maximum; m minimum.

Meteor Showers

The cloudy weather generally prevailing at this season of the year greatly interferes with meteor-observation, but a number of fairly active radiants have been observed, the following amongst others :—From the constellation of the Lynx, R.A. 104° , Decl. 53° N.; from Coma Beren. R.A. 181° , Decl. 35° N.; from near χ Cygni, R.A. 295° , Decl. 53° N. Large meteors should be looked for on January 15, 16, and 17.

STANDARDS OF WHITE LIGHT¹

THE experimental work of the Committee during the past year has not been extensive, as they had no funds at their disposal for experimental research, and they have been chiefly occupied with reviewing what has been done in the past and laying plans for future operations.

Lord Rayleigh has constructed an instrument which he calls a monochromatic telescope, by means of which the illuminated screens of a photometer may be examined, allowing light only of one definite colour to pass. It was hoped by Lord Rayleigh that experiment might show that, with some suitably-chosen colour, this instrument, used with any ordinary photometer, would, in comparing lights of different intensities and temperatures, give to each a candle-power which would be sufficiently accurate to represent for commercial purposes the intensity of the light. The Secretary has made some experiments at the Society of Arts, where he was kindly permitted to use the secondary batteries and glow-lamps; but the results so far are not definite enough to justify their publication.

Mr. Vernon Harcourt has been engaged on an investigation on the barometrical correction to his pentane standard, and on another concerning the possibility of using lamp-shades as a protection from air-currents. His researches are communicated independently to the meeting.

Capt. Abney and Col. Festing have continued their observations on the intensity of radiations of different wave-lengths from incandescent carbon and platinum filaments at different

¹ Report of the Committee, consisting of Prof. G. Forbes, Capt. Abney, Dr. J. Hopkinson, Prof. W. G. Adams, Prof. G. C. Foster, Lord Rayleigh, Mr. Preece, Prof. Schuster, Prof. Dewar, Mr. A. Vernon Harcourt, and Prof. Ayrton, appointed for the purpose of reporting on Standards of White Light. Drawn up by Prof. G. Forbes (Secretary).

temperatures, which will go far to assist the Committee in their work.

Other isolated experiments have been made by members of the Committee, which will be published in due course.

Most of the members have examined the experiments of the Trinity Board at the South Foreland.

Existing Standards.—A consideration of existing standards convinces the Committee that the standard candle, as defined by Act of Parliament, is not in any sense of the word a standard. The French "bec Carcel" is also liable to variations; and with regard to the molten platinum standard of Violle, it seems that the difficulty of applying it is so great as to render its general adoption almost impossible.

With regard to the so-called standard candle, the spermaceti employed is not a definite chemical substance, and is mixed with other materials, and the constitution of the wick is not sufficiently well defined. Hence it is notorious that interested parties may prepare candles conforming to the definitions of the Act which shall favour either the producer or consumer to a serious extent. In view of these defects of the standard candle, it is a matter of great importance that a standard of light should be chosen which is more certain in its indications.

The Committee have looked into the merits of different proposed standards, and the majority feel satisfied that, for all the present commercial requirements, the pentane standard of Mr. Vernon Harcourt—since it has no wick and consumes a material of definite chemical composition—when properly defined, is an accurate and convenient standard, and gives more accurately than the so-called standard candle an illumination equal to that which was intended when the Act was framed.

Yet the Committee, while desiring to impress the Board of Trade and the public with these views, do not feel inclined at present to recommend the adoption of any standard for universal adoption until, further information on radiation having been obtained from experiment, they may learn whether or not it may be possible to propose an absolute standard, founded, like electrical and other standards, on fundamental units of measurement—a standard which, for these reasons, would be acceptable to all civilised nations. They are, however, inclined to look upon the pentane lamp as an accurate means of obtaining an illumination to replace the so-called standard candle.

Proposed Experimental Researches.—Radiation is measured as a rate of doing work, and consequently radiation might be measured in watts. The illumination (or luminous effect of radiation) depends partly upon the eye, and is a certain function of the total radiation. This function depends upon the wave-length of the radiation, or on the different wave-lengths of which the radiation, if it be compound, is composed. This function of the radiation perceived by the eye is partly subjective, and varies with radiations of different wave-lengths and with different eyes. Thus the illumination cannot, like the radiation, be expressed directly in absolute measurement. But the connection between the illumination and the radiation can be determined from a large number of experiments with a large number of eyes, so as to get the value of the function for the normal human eye. This function, however, is constant only for one source of light, or, it may be, for sources of light of the same temperature. It appears, then, that, in the first instance at least, a standard should be defined as being made of a definite material at a special temperature.

The energy required to produce a certain radiation in the case of a thin filament of carbon or platinum-iridium heated by the passage of an electric current can be easily measured by the ordinary electric methods, and the radiation may be measured by a thermopile or a bolometer, which itself can be standardised by measuring the radiation from a definite surface at $100^{\circ}\text{C}.$, compared with the same at $0^{\circ}\text{C}.$ The electric method measures the absorption of energy; the thermopile measures the total radiation. These two are identical if no energy is wasted in convection within the glass bulb of the lamp, by reflection and absorption of the glass, and by conduction from the terminals of the filament. Capt. Abney and Col. Festing have come to the conclusion that there is no sensible loss from these causes. The Committee propose to investigate this further. This constitutes a first research.

No research is necessary to prove that with a constant temperature of a given filament the luminosity is proportional to the radiation, because each of these depends only upon the amount of surface of the radiating filament. It will be necessary, however, to examine whether with different filaments it be

possible to maintain them at such temperatures as shall make the illumination of each proportional to the radiation. This will be the case if spectrum curves, giving the intensity of radiation in terms of the wave-length when made out for the different sources of light, are of the same form. Thus a second research must be undertaken to discover whether the infinite number of spectrum radiation curves, which can be obtained from a carbon filament by varying the current, are identical in form when the filament is changed, but the material remains so far as possible of constant composition.

It will be an object for a later research to determine whether, when the radiation spectrum curve of any source of light has been mapped, a similar curve can be found among the infinite number of curves which can be obtained from a single filament.

The next step proposed is to examine a large number of carbon or of platinum-iridium filaments, and to find whether the radiation spectrum curve of different specimens of the same material is identical when the resistance is changed in all to x times the resistance at $0^{\circ}\text{C}.$ If this law be true, a measurement of the resistance of the filament would be a convenient statement of the nature of the radiation curve. If, then, a number of filaments were thus tested to give the same radiation spectrum curve, their luminosities would in all cases be proportional to their radiations, or (if there be no loss in convection, conduction, absorption, and reflection) proportional to the electrical energies consumed.

Thus it might be hoped to establish a standard of white light, and to define it somewhat in the following manner:—*A unit of light is obtained from a straight carbon filament, in the direction at right angles to the middle of the filament, when the resistance of the filament is one-half of its resistance at $0^{\circ}\text{C}.$, and when it consumes 10^9 C.G.S. units of electrical energy per second.*

Since Mr. Swan has taught us how to make carbon filaments of constant section by passing the material of which they are composed through a die, it is conceivable that another absolute standard should be possible—viz., a carbon filament of circular section, with a surface, say, 1-10th sq. cm., and consuming, say, 10^9 C.G.S. units of energy per second.

Whether such standards are possible or not depends upon the experiments of the Committee. The probability of success is sufficient to render these experiments desirable.

Proposed Later Experimental Researches.—Should these hopes be realised, and an absolute standard of white light thus obtained of a character which would commend it to the civilised world, it would then become an object of the Committee to find the ratio of luminosity when the radiation spectrum curve of the standard filament is varied by varying the current, and consequently the resistance of the filament.

Thus, by a large number of subjective experiments on human eyes, a multiplier would be found to express the illumination from the standard lamp, with each degree of resistance of the filament.

A research, previously hinted at, would then be undertaken—viz., to find whether the radiation spectrum curves of all sources of illumination agree with one or other of the curves of the standard filament. It is not improbable that this should be the case except for the high temperature of the electric arc.

Should this be found to be true, then photometry would be very accurate, and the process would be as follows:—*Adjust the standard filament until its radiation spectrum curve is similar to that of the light to be compared.* (This would probably be best done by observing the wave-length of the maximum radiation, or by observing equal altitudes on either side of the maximum, the instruments used being a spectroscope and a line thermopile or a bolometer.) The total radiation of each is then measured at equal distances by the thermopile. The resistance of the filament is measured, and its intensity in terms of the unit of white light obtained therefrom by the previous research. The luminosity of the compared source of light is then obtained directly.

The Committee desire to be reappointed, and to enable them to carry out the researches indicated they ask for a grant of 30*l.*

PHYSICS AT JOHNS HOPKINS¹

THE large and well appointed laboratories recently erected by the Trustees of the Johns Hopkins University for the Chemical and Biological Departments have by contrast made

¹ From *Science* of December 12, 1885.